school. For example, one teacher of girls proposes to show by furnace and acid that chalk gives off a definite quantity of gas. This seems to me appropriate for an advanced university student, but is not the thing for schools at all.

Experiments to show the indestructibility of matter have this advantage, that you must begin with some matter, and that you must have some appliances on both of which the inquiring mind may feed. But as to where the matter goes to is another matter, and as to what the measurements are all for, you might as well be noting them during the progress of a pantomime.

The same criticisms apply to physiology and botany. It is said we cannot properly study the stomach without a preliminary of histology. If so, they cannot be approached in schools, for histology is a late science and is vain and empty to pupils. The microbes of false ideas are thick in it. But Harvey knew no microscopical histology, and yet he was not altogether a fool. I find boys and girls of fifteen and sixteen studying the alternation of generations in a phanerogam, and not only the nutrition but the respiration of plants. Surely this is pushing on to modern methods with a vengeance. But is there anything gained in development of faculty? Can they *observe* these things, or do they trace a dim something which they are told are there, and recognise them with the wild delight of an irresponsible original researcher? It is the delight of a child who has jumped six feet high with just a little assistance. An independent mind rejects all this and begs for a little exercise in kinds of knowledge which you will find well represented in Pliny.

When we turn back to the books of study which we read as boys of fifteen and sixteen in the times when the ambition to kick a goal or vault ten feet was so strong and so easily ousted other ideas, how many very important laws we find which we then read and now for the first time *know*. I can remember the time when I tried to wake a class to the importance of Boyle and Charles's laws, and I can also remember the time when I remembered that my own old master vainly tried to wake us to it. The result in neither case was thanks, and it was the teachers who were wrong, not the pupils. We do our best, but we are vastly wrong, and we inflict many injustices by force of punishment just as in the old *régime* they broke the rulers over our fathers' shoulders in teaching them practical prosody. A little study of history will lessen this injustice.

At the same time we must distinguish essential historic progress from mere accidents of time. I should be sorry to exclude hydrogen explosions absolutely. JAMES SUTHERLAND.

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Abbe's Optical Theorems.

IN the article, "Optical Science" (NATURE, p. 203), as well as in the preface to Prof. S. P. Thompson's translation of Lummer there mentioned, regret is expressed at the neglect in English text-books of Abbe's contributions to optical theory.

Will you allow me to remark that statements and proofs of Abbe's theorems will be found in §§ 205*b*–205*f* of the 1899 edition of my "Deschanel, Part iv." They occur in the chapter on "Systems of Lenses," and are based on careful study of the writings of Abbe and Czapski.

Ealing, January 9. J. D. EVERETT.

Fireball in Sunshine.

ON Sunday, January 6 last, at 0h. 52m. p.m., a brilliant fireball was seen by many observers in Scotland. The sky was clear and the sun shone brightly at the time. The meteor was observed from Whiteinch Park and Great Western Road, Glasgow, flashing across the north-western sky, and resembling a rocket with a long streaming tail. One correspondent at Glasgow says it travelled from the north-east to west, and that in colour it was like reflected sunlight. Another writer describes it as being of considerable size, "the fiery mass being as large as a bowling ball with a glowing red tail attached." At Killearn, N.B., the object passed from N.W. to W.N.W., and was about 12 degrees above the horizon at the time of its disappearance. It traversed a path of about 20 or 25 degrees, during which it fell about 5 degrees. The radiant of the meteor was probably in Auriga, Perseus, or Aries, so that it belonged to a different system from that which furnished the brilliant daylight fireball of January 9, 1900 (NATURE, January 25, 1900). W. F. DENNING.

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Air and Disease.

IN these days of fresh-air treatment, some of your readers may be interested in a quotation from Palladius "On Husbondrie," an early fifteenth century MS. originally in Colchester Castle.

"The longe-woo," says that writer, "cometh ofte of yvel eire," *i.e.* lung-woe or consumption comes often of bad air. The whole verse describes the effects by which you may know bad air or water, and is, perhaps, worth quoting in its entirety.

> "The longe-woo cometh ofte of yvel eire,
> The stomake eke of eire is overtake,
> Take heede eke yf the dwellers in that leire
> Her wombes, sydes, reynes swell or ake,
> If langoure in thaire bledders ough' awake.
> And if thoue see the people sounde and faire,
> No doubt is in thy water nor thin aire."

Thus we are told that both lungs and stomach are affected by bad air and that, to detect bad air or water we are to see whether the inhabitants have aches in stomachs, &c.

The importance attached so early to air and water may, I think, prove worth mentioning, as it is not what most of us would expect. I came across the passage in turning over the leaves of Lodge's edition of Palladius, published by the Early English Text Society. HAROLD PICTON.

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RECENT ADVANCES IN THE GEOLOGY OF IGNEOUS ROCKS.

THE closing years of the nineteenth century witnessed a revival of interest in the petrology of igneous rocks, which must be regarded as marking an important stage in the development of that subject. Much detailed work, especially in the laboratories of German universities, during the three or four decades preceding had already accumulated a large body of information; but that work had been confined in great measure to the strictly descriptive side of the science—in short, to what is properly described as petrography—and some of it fell rather into the domain of mineralogy and physical optics than of geology. The value of such a store of material cannot be overestimated; but any tendency which promises to shape it into a connected system must be welcomed by geologists as the breath of life animating the valley of dry bones. Such a movement is undoubtedly felt at the present time, and may perhaps be held to mark the transition in petrology from the stage of observation to that of generalisation. An igneous rock has come to be regarded, more constantly than before, not merely as a mineral-aggregate, but as the product of consolidation of a molten rock-magma; and consideration has been directed to the constitution of such magmas and the conditions governing their consolidation. Recognition of the importance of studying the mode of occurrence of igneous rocks and their relations to one another has led to a closer union of observation in the field with research in the laboratory. Much is being learnt concerning the geographical distribution of the rocks, their connection with crust-movements, and the sequence of eruption of different types at a given centre. The facts thus acquired, and especially the fertile conception of "petrographical provinces," each with its suite of igneous rocks having a community of characters which bespeaks a common origin, have confirmed the conviction that widely diverse rock-types may be evolved from a common parent-magma. Hence arises the problem, to which Brögger and others have boldly addressed themselves, of the processes by which such "differentiation" is effected and the conditions which control them. Hence, too, another problem, a corollary to the former, to frame a natural classification of igneous rocks, based on genetic principles, to supersede the provisional classifications on various artificial or Linnæan schemes which are at present current. The questions involved obviously present great difficulties, and petrologists would be the first to admit that some of their speculations are of a crude and tentative nature. It is greatly to be desired that students of physical chemistry should turn their attention to petrology; the more so since some subjects, such as the nature of solutions and the constitution of alloys, which have recently been advanced in their hands, may be found to have important applications to the crystallisation of igneous rock-magmas.

Petrological research during the last few years serves especially to emphasise the value of comparative studies of different areas. There are large regions throughout which the igneous rocks show but relatively slight departures from one common type, while elsewhere comparatively small districts exhibit a surprising range of variation. Peculiar rock-types, supposed to be unique and to have the most narrowly restricted occurrence, have in some instances been found to recur at widely separated centres with the same associates and with like geological relations. More generally there are differences as well as resemblances, the rocks of two districts constituting two parallel suites, such that each type in the one suite has its representative in the other. Such a parallelism is that drawn by Brögger between the Monzoni and the Christiania rocks. It points clearly to two somewhat similar, but not identical, parent-magmas having undergone differentiation on similar lines. The investigations of the United States Geological Survey, and of other American geologists, afford numerous illustrations of these and other points. The intrusive masses in the High Plateaux region along the west side of the Rocky Mountains, furnishing, as Gilbert first showed, such beautiful examples of the laccolitic form, are, according to Cross, almost wholly of diorite, diorite-porphyrite, &c. The region lying along, and to the east of, the Rocky Mountains, from Montana to Texas, differing widely from the former belt in geological structure, is equally in contrast with it petrographically. The rocks here are generally richer in alkalies, and they embrace a remarkable profusion of types and varieties. Especially is this seen in the accounts given by Weed and Pirsson of the several mountain-groups of Montana. Some of the rock-types described are new and unique, such as missourite, a leucite-gabbro without felspar; but most of them compare with rocks already known from other areas, though usually presenting points of difference which may be significant. The memoir by Cross and Penrose on the Cripple Creek district, Colorado, may also be cited in the same connection. This district and some of the others alluded to are important mining centres, and it is very interesting to notice how economic geology and what may be termed pure petrology assist one another. Some of the economic questions raised, such as the source and origin of the Montana sapphires (Pirsson, *Amer. Journ. Sci.* 1897, vol. iv. p. 421), may be found to have no unimportant application to the chemistry of igneous rock-magmas.

Since it is not possible in a short article to give even a summary of the actual results of petrological work during late years, we confine ourselves to a few examples. In Britain one result of recent researches, by the Geological Survey and other workers, has been to reveal the occurrence of a number of rock-types hitherto but little known, or wholly unrecorded, in this country. Among them are rocks of the syenite and nepheline-syenite families and the related families of dyke-rocks, some closely comparable, and probably contemporaneous, with the remarkable suite of Devonian intrusions of the Christiania basin. Especially interesting is Teall's brief account of the intrusive masses of Cnoc na Sròine and its vicinity, in the western part of Sutherland. The main mass is found to consist of a quartz-syenite of the nordmarkite type, which graduates on the one hand into a granite, on the other into quartzless syenite, nepheline-syenite, and the rock formerly described under the name borolanite. The last-named rock is composed essentially of orthoclase and melanite garnet with some ægirine-augite and alteration-products of nepheline. A peculiar feature is the occurrence in it of polygonal pseudomorphs doubtless representing leucite, and the rock is practically identical with the so-called leucite-syenite of Magnet Cove in Arkansas. The associated minor intrusions—sills and dykes—are partly of dark hornblendic rocks approaching camptonite, partly of light felspathic rocks containing ægirine, and comparable in different varieties with the grorudite, lindöite, &c., of the Christiania district. The distribution and petrography of the Scottish lamprophyres and the peculiar felspathic rocks which seem to be their natural complements are as yet imperfectly known; but Flett, *Trans. Roy. Soc. Edin.* (1900) vol. xxxix., p. 865, has described from the Orkneys dykes of bostonite, camptonite, monchiquite and alnöite, and some of these types are known to be represented in various parts of the Highlands. Camptonites and augite-camptonites are described by Hill and Kynaston in Argyllshire, where they are genetically related to another remarkable rock-type, kentallenite, which in its association of alkali-felspar with olivine and augite resembles the olivine-monzonite of Predazzo. The kentallenite itself is related to, and occurs in part as a marginal facies of, the large granite and tonalite masses of the district. This is only one example of the very heterogeneous nature of the intrusions marked on the geological maps of Scotland as granite. The same variability characterises them from the Galloway "granites," recently described by Teall in a Survey Memoir, to the large intrusion of Aberdeen, where the extreme basic modifications are represented by troctolite and peridotite (bastite-serpentine). An interesting group of minor intrusions, as yet only partially described, includes the orthophyres, lamprophyres, and quartz-basalts of South Devon. Finally we may mention a unique rock described by Judd (*Trans. Roy. Irish Acad.* (1897) vol. xxxi. p. 48), and named rockallite after the the remote islet where it occurs. It is a peculiar granite-porphyry consisting of ægirine, quartz and albite; differing from Brögger's grorudite, and from other acid rocks, in its remarkable richness in iron and poverty in alumina and in the absence of potash.

One point worthy of remark is the way in which various crystalline rocks, to which more or less of obscurity has attached, are being reclaimed from the limbo of "gneisses," "granulites," &c., and recognised, some as true products from igneous fusion, others as metamorphosed sediments. A recently published memoir by Holland (*Mem. Geol. Surv. India* (1900), vol. xxviii.) establishes the igneous origin, and describes the petrographical characters, of an important group of Archæan rocks in southern India. We may note incidentally, as illustrating the increasing hold which the idea of genetic grouping is obtaining among petrologists, that the author boldly uses the name "charnockite series" for an assemblage of types ranging in composition from acid to ultrabasic. Their community of origin is attested not only by their intimate association but by remarkable points of resemblance which run through the whole series. The constant presence of hypersthene in the rocks is one characteristic, and the common acid type, to which the name charnockite is given, is in fact a hypersthene-granite. The component minerals exhibit an astonishing freshness of preservation. Since rocks generally similar have been described, under such names as pyroxene-gneiss, pyroxene-granulite, &c., as occupying very extensive areas in Peninsular India, Ceylon, and Burma, a proper appreciation of their nature and origin is a matter of considerable importance.

Microscopical research and chemical analysis, as representing, on the side of the laboratory, the groundwork of all our knowledge of rocks, must necessarily retain the important position which they occupy; and in both fields improved methods are coming into general use, which impart increased precision to the results. Michel-Lévy's elaborate discussion of the optical properties of the felspars has greatly facilitated the discrimination of the several varieties; while among special instruments we may recall Fedorow's "universal theodolite," enabling accurate optical measurements to be made on crystals in random sections. The application of dense liquids to determine the specific gravity of minute fragments of minerals, and to obtain pure material for analysis, has been perfected, and, especially in the form of Sollas's "diffusion column," has been made both simple and convenient for use. The importance of accuracy and completeness in the chemical analysis of rocks has become more generally recognised. Many of the most valuable rock-analyses published in late years are due to the United States Geological Survey, who have realised the importance of maintaining an adequate staff of skilled chemists. One point brought out is the wide distribution in igneous rocks of small amounts of the heavy metals, and of some other elements, such as barium and strontium. Apart from its obvious application to questions concerning the origin of metalliferous deposits, information of this kind will probably be found to throw some light upon matters of more strictly petrological interest.

THE DISAPPEARANCE OF IMAGES ON PHOTOGRAPHIC PLATES.

IT is the aim of the modern astronomer to employ photography, whenever possible, in the many branches of his work, as by this means the peculiarities of the observer are eliminated and a permanent record is obtained that can be examined at leisure at any later date. In some kinds of work photography helps us in obtaining a great number of facts in a very short space of time, facts which would have taken weeks to accumulate by the old method of eye observation. Not only is the science more rapidly advanced by the greater abundance of material at hand, and therefore available for discussion, but the application of photography to astronomy has opened up so many new fields of work that the whole subject has now a far wider horizon than before.

To be able to photograph in a few hours objects which for ever will be outside the reach of the human eye, however aided, is one of the many marvels of this invaluable method.

The fine photographs obtained to-day, and so well illustrated in our books by the aid of the modern processes of reproduction, suggest the importance of recording the appearances of these celestial objects after some years have elapsed, in order to be able to note whether any changes in brightness or form are occurring. The magnificent work of the "Carte du Ciel," started by the far-seeing mind of Admiral Mouchez, is one of those schemes on a large scale for obtaining a survey of the universe at the close of the nineteenth century. The many thousands and thousands of photographic plates that will have been exposed to the sky when this plan will have been accomplished point out to us the immense importance that must be attached, not only to the "*keeping*" qualities of the film on the glass plates, but also to the retention of the *images* on these films.

Since one of the chief objects of Admiral Mouchez's plan was to hand down to posterity a chart of the celestial vault as recorded in our time, to enable those that follow us to compare with it that recorded in their time, the importance of the preservation of the photographic films, and the images impressed on them, cannot be overrated.

Most of the readers of NATURE are familiar with those beautiful photographs of long exposure of nebulæ and star clusters which we owe to the skill and patience of Dr. Isaac Roberts, and which he has given to the world in two magnificent volumes of plates. In the second of these volumes Dr. Roberts makes some very interesting and valuable remarks regarding the "fading" of some of the images on the photographic plates, and his experience shows that such disappearances of images after long intervals of time may assume very considerable proportions.

Although the period over which his experience extended only covered about ten years, this interval of time was sufficiently long to enable him to obtain some very striking facts.

The following brief summary of the two instances which he recorded in his second volume will give the reader a general quantitative idea of the disappearances of images during a short period.

A photograph of a region of the sky was taken on February 15 in 1886, and 403 star-images were counted on the negative. A re-count on May 29, 1895, found only 272 images, a loss of 131 images in about nine and three-quarter years.

Again, another photograph of identically the same region, taken on March 22, 1886, recorded 364 stars; the same plate, examined in May 1895, showed only 234.

These facts, then, indicate that, even after so short a period as ten years or so, the photographic film cannot be depended on, and that for lasting purposes recourse must be made to some means of reproducing the photographs soon after they have been obtained, the reproductions being as faithful to the originals as possible. It is generally known that, in nearly every method of reproduction, very faint details are lost in the process, but this loss could be easily recorded by noting the slight differences at the time; printed on good paper and with permanent ink, such reproductions should be lasting.

The fact that the great photographic chart of the sky is approaching completion causes one to think of the great expense that will be involved in reproducing the large number of individual plates. That many of the observatories which have taken part in this undertaking will find some difficulty in at once getting together the necessary funds is quite possible, so that a delay of a few years may be detrimental to the accuracy of the chart.

It is therefore very important that some means should be at hand to prevent the images of the fainter objects from fading quite away, or, if already disappeared, to bring them back to view.

Fortunately, the latter alternative can be accomplished by a process of manipulation which we owe to Sir William Crookes.

The completeness and success of this method will be gathered from the fact that when Sir William Crookes had "revived" one of Dr. Roberts' negatives that had entirely lost many images, the latter, on re-counting, "found that every one of the missing images had been restored to view, as distinctly, I think, as they were after the negatives were first developed."

The process by which Sir William Crookes accomplished this has been published in detail by Dr. Roberts in the *Monthly Notices* of the Royal Astronomical Society (vol. lxi., No. 1) for last November. As the description should prove of interest and service to many of our readers, the following account is appended, as described by Sir William Crookes himself in a letter to Dr. Roberts.

"(1) Soak the plate for three hours in distilled water.

(2) Prepare, in advance, two solutions A and B.

Solution A.		Solution B.	
Pyrogallic acid	1 oz.	Sodium carbonate (crystals)	12 oz.
Sodium metabisulphite	1 oz.	Sodium sulphite	4 oz.
Water	80 oz.	Water	80 oz.